



US009257691B2

(12) **United States Patent**
Wang et al.

(10) **Patent No.:** **US 9,257,691 B2**
(45) **Date of Patent:** **Feb. 9, 2016**

(54) **BATTERY PACK**

(71) Applicant: **SAMSUNG SDI CO., LTD.**, Yongin-si,
Gyeonggi-do (KR)

(72) Inventors: **Han-Jun Wang**, Yongin-si (KR);
Dae-Yon Moon, Yongin-si (KR);
Hee-Youn Won, Yongin-si (KR)

(73) Assignee: **SAMSUNG SDI CO., LTD.**, Yongin-si,
Gyeonggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/451,958**

(22) Filed: **Aug. 5, 2014**

(65) **Prior Publication Data**

US 2015/0228954 A1 Aug. 13, 2015

(30) **Foreign Application Priority Data**

Feb. 11, 2014 (KR) 10-2014-0015641

(51) **Int. Cl.**

H01M 2/24 (2006.01)
H01M 6/42 (2006.01)
H01M 2/20 (2006.01)
H01M 2/10 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **H01M 2/202** (2013.01); **H01M 2/10**
(2013.01); **H01M 2/1016** (2013.01); **H01M**
2/1061 (2013.01); **H01M 10/42** (2013.01);
H01M 10/4257 (2013.01); **H01M 10/486**
(2013.01); **H01M 2220/30** (2013.01)

(58) **Field of Classification Search**

CPC H01M 10/425; H01M 2/1061; H01M
2220/30; H01M 2/1022; H01M 2/202; H01M
2/204; H01M 2/348; H01M 10/0431; H01M

10/0525; H01M 10/4207; H01M 10/443;
H01M 10/482; H01M 10/486; H01M 10/5004;
H01M 10/5044; H01M 2010/4271; H01M
2200/10; H01M 2/0207; H01M 2/1016;
H01M 2/1066

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,738,906 A * 4/1988 Sanders 429/120
4,871,553 A * 10/1989 Huhndorff 429/61

(Continued)

FOREIGN PATENT DOCUMENTS

EP 2109166 A1 10/2009
JP 11-135088 5/1999

(Continued)

OTHER PUBLICATIONS

Kouta, Secondary Battery Pack, English Translation, JP11-135088,
May 21, 1999.*

Primary Examiner — Patrick Ryan

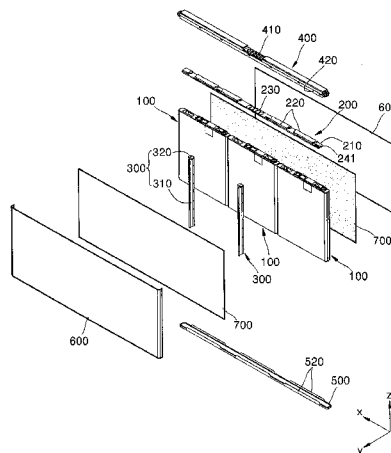
Assistant Examiner — Jose Colucci Rios

(74) *Attorney, Agent, or Firm* — Lee & Morse, P.C.

(57) **ABSTRACT**

A battery pack includes a plurality of battery units that are side by side along a first direction, a connection member that connects the battery units in series, in parallel, or in series and parallel, the connection member being adjacent to one surface of each battery unit of the plurality of battery units, an upper cap on and accommodating the connection member, upper portions of all of the battery units being inserted into the upper cap, a lower cap that is spaced apart from the upper cap by a predetermined gap, lower portions of all of the battery units being inserted into the lower cap, and a label that at least partially surrounds the battery units exposed between the upper cap and the lower cap. The upper cap and the lower cap fix an arrangement of the battery units.

12 Claims, 5 Drawing Sheets



2011/0086243	A1 *	4/2011	Bae et al.	429/7
2011/0300433	A1 *	12/2011	Kim	429/159
2012/0052331	A1	3/2012	Park et al.	
2012/0214024	A1 *	8/2012	Moon et al.	429/7
2012/0214025	A1 *	8/2012	Moon et al.	429/7
2012/0214026	A1	8/2012	Moon et al.	

FOREIGN PATENT DOCUMENTS

JP	2007-506242		3/2007
JP	2009-87937		4/2009
JP	2010-192426		9/2010
JP	2011-258542		12/2011
JP	2012-113973		6/2012
KR	10-2008-0017321		2/2008
KR	10-2010-0082530		7/2010
KR	10-2012-0020044		3/2012
KR	10-2012-0094706		8/2012
KR	20-0466244		3/2013
WO	10-2006-0039377		5/2006
WO	WO-2013/187687	A1	12/2013

* cited by examiner

FIG. 1

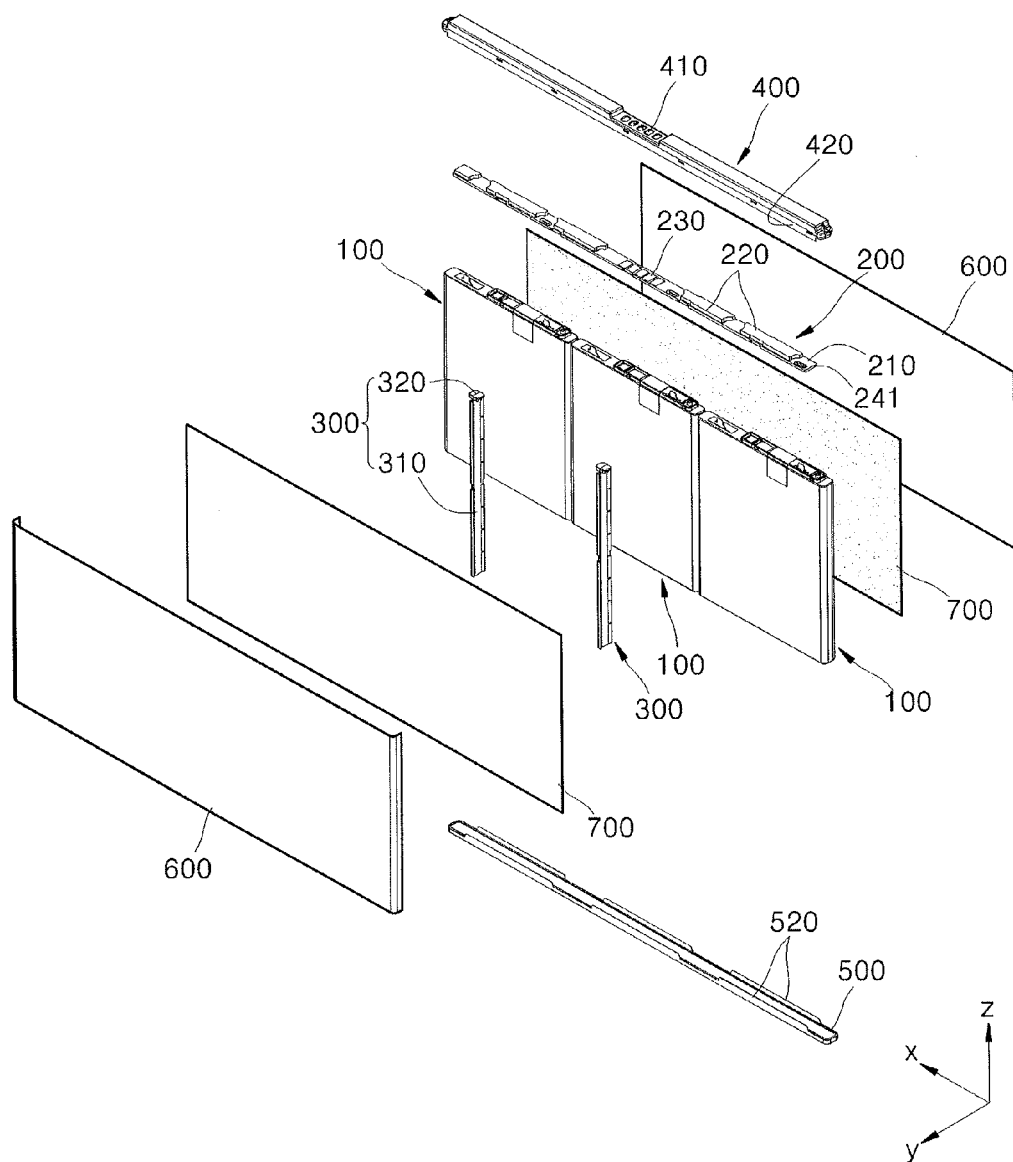


FIG. 2

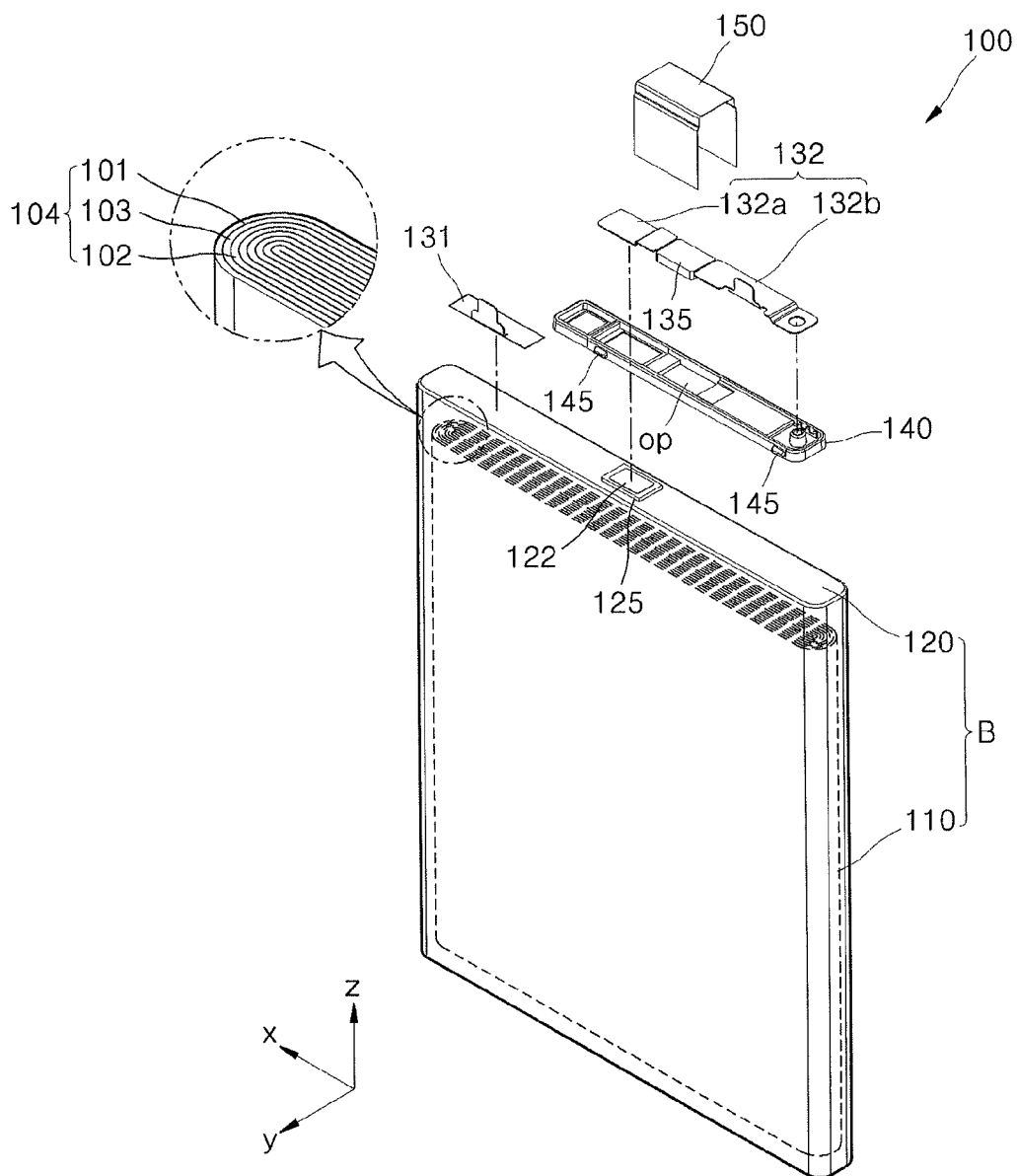


FIG. 3

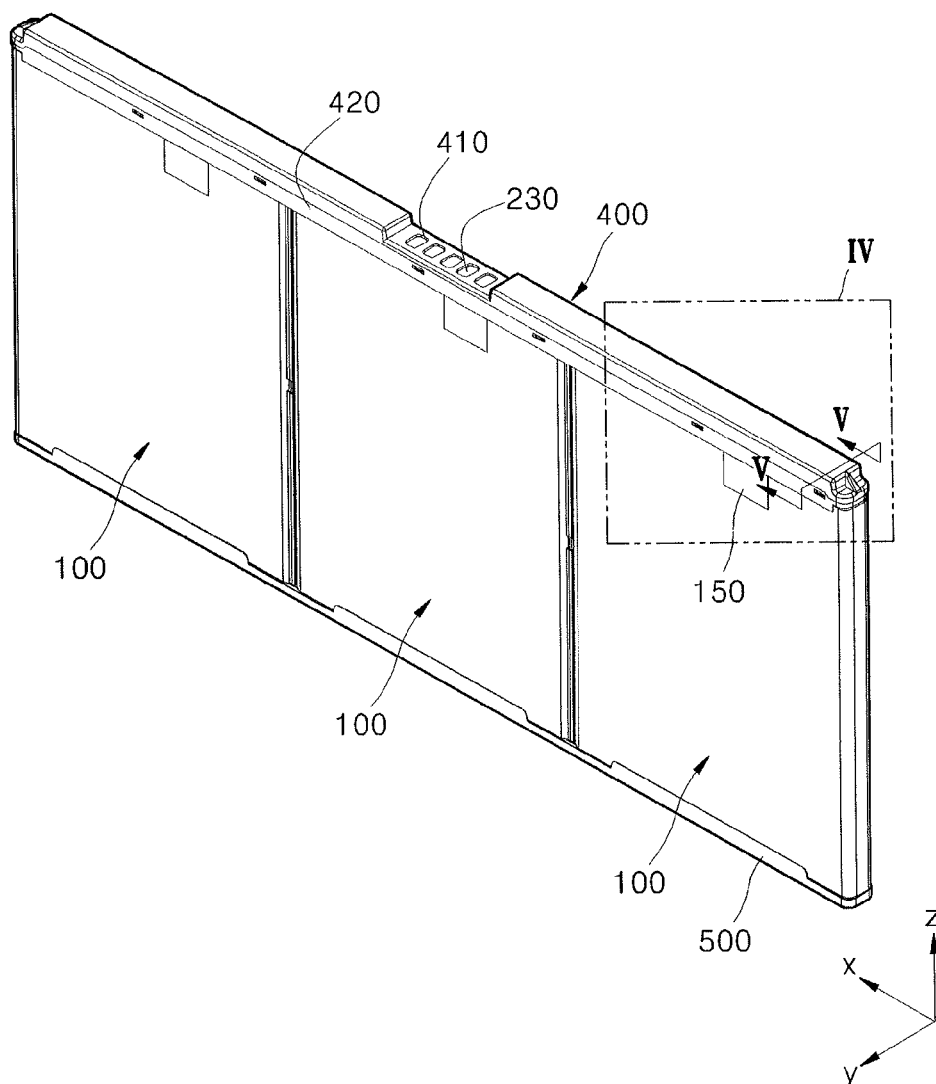


FIG. 4

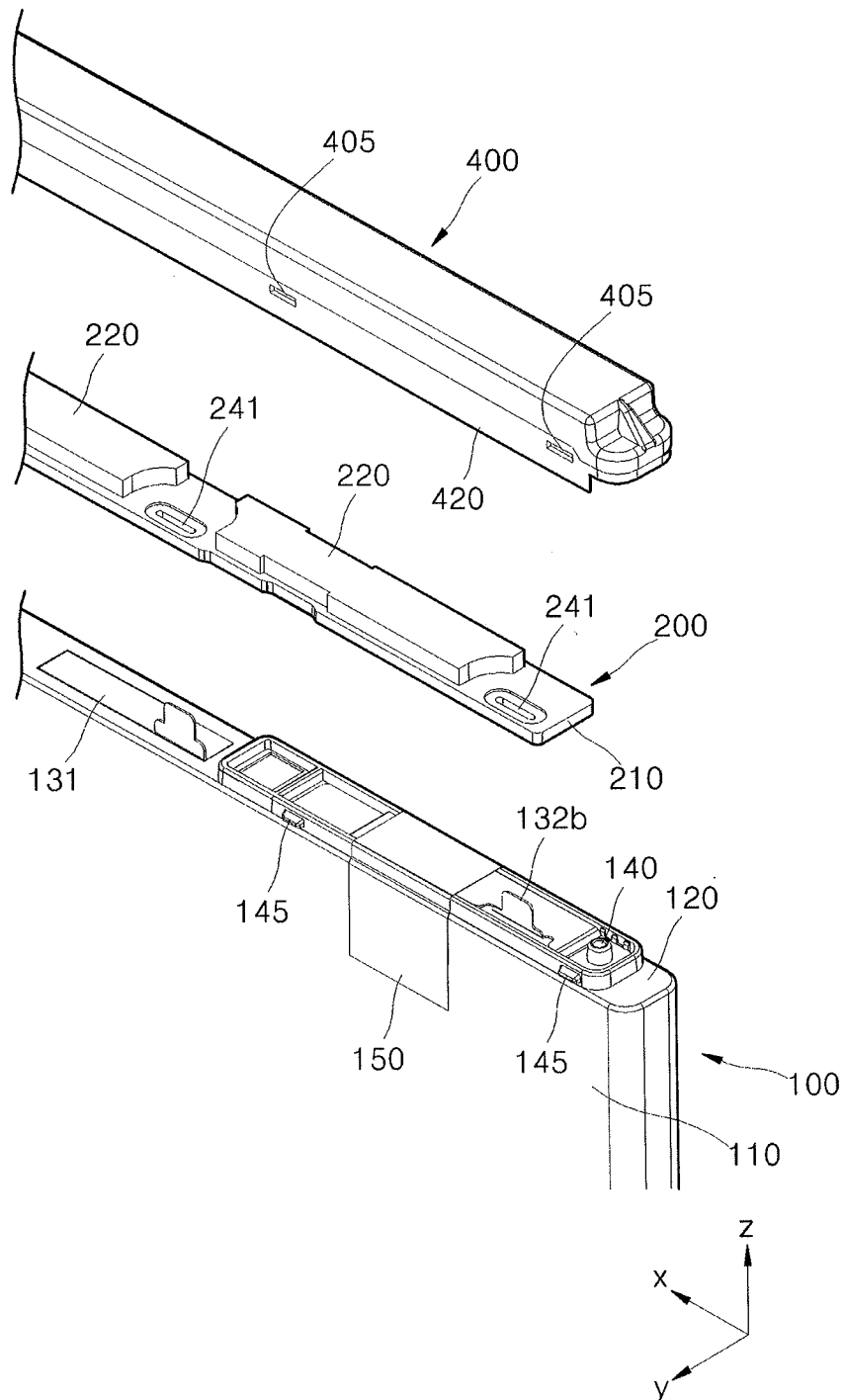
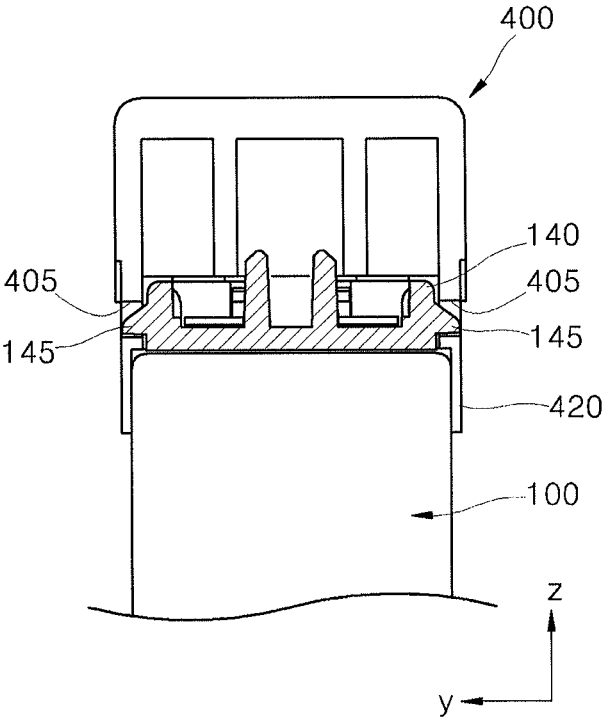


FIG. 5



1

BATTERY PACK

RELATED APPLICATIONS

Korean Patent Application No. 10-2014-0015641, filed on Feb. 11, 2014, in the Korean Intellectual Property Office, and entitled: "Battery Pack," is incorporated by reference herein in its entirety.

BACKGROUND

1. Field

One or more embodiments relate to a battery pack.

2. Description of the Related Art

Use of portable computers that operate based on internal power supplied from batteries has dramatically increased due to the development of wireless communication technologies such as the Internet. In general, since the portable computers are small and easy to carry, that is, have high mobility, the portable computers are widely used for business or personal purposes in various places. As the portable computers include battery packs, they may be used irrespective of the area of use and connection to land power sources. A battery pack may include a plurality of battery units that may be repeatedly charged/discharged so as to provide sufficient output.

SUMMARY

Embodiments are directed to a battery pack including a plurality of battery units that are side by side along a first direction, a connection member that connects the battery units in series, in parallel, or in series and parallel, the connection member being adjacent to one surface of each battery unit of the plurality of battery units, an upper cap on and accommodating the connection member, upper portions of all of the battery units being inserted into the upper cap, a lower cap that is spaced apart from the upper cap by a predetermined gap, lower portions of all of the battery units being inserted into the lower cap, and a label that at least partially surrounds the battery units exposed between the upper cap and the lower cap. The upper cap and the lower cap fix an arrangement of the battery units.

Each of the battery units may include sides that are perpendicular to the one surface. The sides may include a pair of first sides, the first sides of each battery unit being side by side with the first sides of the other battery units, and a pair of second sides that connect the pair of first sides to each other, the second sides having a smaller width than the first sides. The plurality of battery units may be arranged such that the second sides of adjacent battery units face each other.

The battery pack may further include a spacer between the second sides of adjacent battery units that face each other.

The spacer may include a first portion that insulates the second sides of the adjacent battery units from each other and a second portion that extends from the first portion to the connection member and supports the connection member.

At least one of the upper cap and the lower cap may include a skirt portion that extends toward the pair of first sides. The label may be attached to the skirt portion.

The battery pack may further include an insulating film between at least one of the pair of first sides and the label.

Each battery unit may include a can that accommodates an electrode assembly and a cap plate that is combined with the can, the cap plate forming the one surface. Each battery unit may include an electrode pin located on the cap plate, the electrode pin being insulated from the cap plate.

2

Each battery unit may include a holder on the cap plate, the holder accommodating a temperature-sensing element connected to the electrode pin.

The connection member may be electrically connected to the electrode pin and the cap plate.

The connection member may include circuit boards and protective elements mounted on the circuit boards.

The holder may be coupleable with the upper cap.

One of the holder and the upper cap may include a protrusion that protrudes in a direction perpendicular to the first direction, and the other one of the holder and the upper cap may include a hole that is coupleable with the protrusion.

BRIEF DESCRIPTION OF THE DRAWINGS

Features will become apparent to those of skill in the art by describing in detail exemplary embodiments with reference to the attached drawings in which:

FIG. 1 illustrates a schematic perspective view of a battery pack according to an embodiment;

FIG. 2 illustrates an exploded perspective view of one of a plurality of battery units illustrated in FIG. 1;

FIG. 3 illustrates a perspective view depicting a state in which battery units, a protective circuit module, an upper cover, and a lower cover illustrated in FIG. 1 are assembled;

FIG. 4 illustrates an exploded perspective view of a portion IV of FIG. 3; and

FIG. 5 illustrates a cross-sectional view taken along a line V-V of FIG. 3.

DETAILED DESCRIPTION

Example embodiments will now be described more fully hereinafter with reference to the accompanying drawings; however, they may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey exemplary implementations to those skilled in the art.

In the drawing figures, the dimensions of layers and regions may be exaggerated for clarity of illustration. Like reference numerals refer to like elements throughout.

FIG. 1 is a schematic perspective view of a battery pack according to an embodiment, FIG. 2 is an perspective view of one of a plurality of battery units and a holder illustrated in FIG. 1, and FIG. 3 is a perspective view illustrating a state in which a plurality of battery units **100**, a protective circuit module **200**, an upper cover **400**, and a lower cover **500** are assembled. In FIG. 3, a label **600** and an insulating film **700** are omitted in FIG. 3 for convenience of explanation.

Referring to FIGS. 1 through 3, the battery pack according to the current embodiment may include the plurality of battery units **100**, the protective circuit module **200**, which is electrically connected to each of the plurality of battery units **100**, a spacer **300** that electrically insulates the battery units **100** from each other, the upper cover **400**, the lower cover **500**, the label **600**, and the insulating film **700**.

The plurality of battery units **100** may be disposed side by side along a first direction (x-direction). For example, the plurality of battery units **100** may be disposed side by side so that their top surfaces are in the same direction. Sides of adjacent battery units **100** may face each other. Each of the battery units **100** may be a lithium-ion battery, that is, a secondary battery that may be recharged.

Referring to FIG. 2, each of the battery units **100** may include a bare cell B and a holder **140** fixed to an upper portion of the bare cell B.

The bare cell B may include a can **110** having an opening formed therein, an electrode assembly **104** accommodated in the can **110** through the opening, a cap plate **120** that seals the opening of the can **110**, and an electrode pin **122** formed on the cap plate **120**.

The can **110** may have an opened, approximately hexahedral top surface and may be manufactured of a metallic material so as to have a suitable resistance. For example, the can **110** may be manufactured of aluminum (Al) or an Al alloy. After the electrode assembly **104** is inserted into the can **110** through the opening, the opening may be sealed by the cap plate **120**. Like the can **110**, the cap plate **120** may be manufactured of a metallic material, such as aluminum or an Al alloy. Portions at which the cap plate **120** and the can **110** contact each other may be combined with each other through laser welding so that an internal air-tight state of the bare cell B may be maintained.

The electrode assembly **104** may include a first electrode plate **101** and a second electrode plate **102** onto which an electrode active material is coated, and a separator **103** interposed therebetween. The first electrode plate **101** and the second electrode plate **102** may have different polarities. The electrode assembly **104** may be manufactured in such a way that the first electrode plate **101**, the separator **103**, and the second electrode plate **102** may be sequentially stacked on the electrode assembly **104** and then be wound in a jelly roll shape. In other implementations, the electrode assembly **104** may be a stack structure where the first electrode plate **101**, the separator **103**, and the second electrode plate **102** are sequentially stacked.

The electrode pin **122** may be formed on the cap plate **120**. The first electrode plate **101** may be electrically connected to the cap plate **120**, and the second electrode plate **102** may be electrically connected to the electrode pin **122**. The first electrode plate **101** and the second electrode plate **102** may have different polarities. Accordingly, the electrode pin **122** and the cap plate **120** may have different polarities. For example, the electrode pin **122** may have a negative electrode polarity, and the cap plate **120** may have a positive electrode polarity. A gasket **125** may be provided between the electrode pin **122** and the cap plate **120** so as to prevent a short circuit between the electrode pin **122** and the cap plate **120**. The gasket **125** may be manufactured of an insulating material and may prevent an electrical short circuit between the electrode pin **122** and the cap plate **120**.

The battery unit **100** may include first and second electrode tabs **131** and **132**. The first and second electrode tabs **131** and **132** may serve as a positive electrode terminal and a negative electrode terminal of a secondary battery.

For example, the first electrode tab **131** may be disposed on the cap plate **120** and may be electrically connected to the cap plate **120**. When the cap plate **120** has a positive electrode polarity, the first electrode tab **131** welded onto the cap plate **120** may also have a positive electrode polarity.

The second electrode tab **132** may be connected to the electrode pin **122** and a temperature-sensing element, such as a temperature cutoff (TCO). For example, the second electrode tab **132** may include a first portion **132a** and a second portion **132b**. One end of the first portion **132a** may be connected to the electrode pin **122**, and the other end of the first portion **132a** may be connected to the temperature-sensing element. One end of the second portion **132b** may be connected to the temperature-sensing element so that the second electrode tab **132** including the temperature-sensing element may be electrically connected to the electrode pin **122**.

The first and second electrode tabs **131** and **132** may be disposed on the cap plate **120**. Since the cap plate **120** has a

positive electrode polarity, as described above, an electrical short circuit between the cap plate **120** and the second electrode tab **132** having a negative electrode polarity could occur easily. Thus, the second electrode tab **132** may be disposed on the holder **140** put on the cap plate **120**.

The holder **140** may accommodate the second electrode tab **132** and the temperature-sensing element. The holder **140** may include an opening **op** formed in a position corresponding to a position of the temperature-sensing element so as to sensitively react to a change in temperature of the battery unit **100**.

The holder **140** may be fixed onto the battery unit **100** using a fixing member, such as a tape **150**, while accommodating the second electrode tab **132** and the temperature-sensing element.

The holder **140** may include a protrusion **145**. The protrusion **145** may extend and protrude from the holder **140** along a thickness direction (y-direction) of the battery unit **100** and may be combined with a hole **405** formed in the upper cover **400** that will be described below. For example, the protrusion **145** of the holder **140** may be combined with the hole **405** of the upper cover **400** through interference fit.

In the current embodiment, the protrusion **145** is formed on the holder **140**, and the hole **405** is formed in the upper cover **400**. In other implementations, a hole may be formed in the holder **140**, and a protrusion may be formed on the upper cover **400** so that the protrusion and the hole may be combined with each other through an interference fit. Considering the overall thickness of the battery pack, for example, the protrusion **145** may be formed on the holder **140** and the hole **405** may be formed in the upper cover **400**, such that the thickness of the battery pack may be reduced.

Referring back to FIGS. 1 through 3, the protective circuit module **200** may be disposed on a top surface of each battery unit **100**, for example, on the cap plate **120**, and may be electrically connected to the battery unit **100** such that charging/discharging of the battery unit **100** may be controlled. The protective circuit module **200** may prevent overheating and explosion that occur due to overcharging, overdischarging, or overcurrent of the battery unit **100**.

The protective circuit module **200** may include circuit boards **210**, protective elements **220** mounted on the circuit boards **210**, and external terminals **230**. The circuit boards **210** may extend long along an arrangement direction of the plurality of battery units **100**. The protective elements **220** may be one selected from the group of safety elements including passive elements, such as resistors and capacitors of the circuit boards **210**, or active elements, such as field effect transistors (FETs), or integrated circuits (ICs).

Each of the circuit boards **210** may include a connection hole **241**. The first and second electrode tabs **131** and **132** provided on each of the battery units **100** may be inserted into the connection hole **241** formed in each circuit board **210**. The first and second electrode tabs **131**, **132** and the respective circuit board **210** may be soldered together. Patterns through which the battery units **100** may be connected in series and/or in parallel, may be formed on the circuit board **210**. The first and second electrode tabs **131** and **132** of each battery unit **100** may be directly connected to the connection hole **241** formed in the circuit board **210** such that the plurality of battery units **100** may be charge/discharge-controlled according to driving of the protective element **220** and simultaneously may be connected in series and/or in parallel.

The spacer **300** may be interposed between adjacent battery units **100**. One end of the spacer **300** may extend toward the protective circuit module **200** so as to support the protective circuit module **200**. For example, the spacer **300** may

5

include a first portion 310 interposed between the adjacent battery units 100, and a second portion 320 that extends from the first portion 310 to the protective circuit module 200.

The first portion 310 of the spacer 300 may electrically insulate the adjacent battery units 100 from each other. As described above with reference to FIG. 2, the can 110 and the cap plate 120 of the battery unit 100 may be manufactured of a metallic material, and the can 110 may be welded to the cap plate 120 such that the can 110 may have the same polarity as that of the cap plate 120. When the battery units 100 are disposed side by side, as illustrated in FIG. 1, an undesired electrical connection between the adjacent battery units 100 could be formed. According to an embodiment, the first portion 310 of the spacer 300 may be interposed between the adjacent battery units 100. Accordingly, an undesired electrical connection between the adjacent battery units 100 may be prevented.

The second portion 320 of the spacer 300 may be interposed in a space (or a gap) between the protective circuit module 200 and the battery unit 100 and may support the protective circuit module 200. The battery unit 100 may include the electrode pin 122 that protrudes upward and the holder 140 may be interposed on the battery unit 100. Accordingly, a space may be formed between the top surface of the battery unit 100 and a bottom surface of the protective circuit module 200. When the second portion 320 of the spacer 300 is interposed in the space, the protective circuit module 200 may be supported and simultaneously may be protected from an external force applied to the protective circuit module 200.

The upper cover 400 may be disposed on the protective circuit module 200. The upper cover 400 may include an opening 410 through which the external terminal 230 formed on the protective circuit module 200 is exposed.

The upper cover 400 may have a length that is substantially the same as the entire length of the plurality of battery units 100 disposed side by side along the first direction. The upper cover 400 may be combined with the battery units 100 such that the protective circuit module 200 may be interposed between the battery units 100. For example, the upper cover 400 and the holder 140 provided at each of the battery units 100 may be combined with each other through an interference fit, as described above.

The lower cover 500 may be disposed at an opposite side to a side at which the upper cover 400 is disposed, so as to face the upper cover 400. The upper cover 400 may be disposed to cover the top surface of each battery unit 100, with the protective circuit module 200 being interposed between the battery units 100. The lower cover 500 may be disposed to cover the bottom surface of each battery unit 100.

The label 600 may be disposed to surround sides of each battery unit 100. For example, the label 600 may be attached to the sides of the battery unit 100. An insulating film 700 may be interposed between the label 600 and the sides of the battery unit 100.

Portions of the label 600 may be attached to the upper cover 400 and the lower cover 500. To this end, skirt portions 420 and 520 may be provided at the upper cover 400 and the lower cover 500 and may extend toward the battery unit 100. The portions of the label 600 may be attached onto the skirt portions 420 and 520 such that the upper cover 400, the lower cover 500, and the label 600 may be insulated from the battery unit 100 and simultaneously, such that the battery unit 100 may be prevented from being exposed to the outside.

Hereinafter, a combination of the upper cover 400 and the battery unit 100, for example, a combination of the upper cover 400 and the holder 140 of the battery unit 100 will be described with reference to FIGS. 4 and 5.

6

FIG. 4 is an partial exploded perspective view of a portion IV of FIG. 3, and FIG. 5 is a cross-sectional view taken along a line V-V of FIG. 3.

Referring to FIGS. 4 and 5, the protective circuit module 200 may be disposed on the battery unit 100, and the upper cover 400 may be disposed on the protective circuit module 200. The protective circuit module 200 may be placed on the cap plate 120 on which the electrode pin 122 is formed. The first and second electrode tabs 131 and 132 included in each battery unit 100 may be inserted into the connection holes 241 formed in the protective circuit module 200 and then the first and second electrode tabs 131 and 132 and the protective circuit module may be soldered together. Thus, the first and second electrode tabs 131 and 132 may be electrically connected to the protective circuit module 200.

The upper cover 400 may be combined with the battery unit 100 such that the protective circuit module 200 is interposed between the battery unit 100 and the upper cover 400. For example, the upper cover 400 may include the hole 405, and the holder 140 of the battery unit 100 may include the protrusion 145. The protrusion 145 may be combined with the hole 405 through an interference fit such that the upper cover 400 and the holder 140 are combined with each other. The protrusion 145 may extend and protrude from the battery unit 100 along the thickness direction (y-direction) of the battery unit 100 and thus may be combinable with the hole 405 of the upper cover 400.

As described above, according to the one or more of the above embodiments provide a compact battery pack having improved assembling characteristics may be provided.

Example embodiments have been disclosed herein, and although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. Accordingly, it will be understood by those of skill in the art that various changes in form and details may be made without departing from the spirit and scope as set forth in the following claims.

What is claimed is:

1. A battery pack, comprising:

- a plurality of battery units that are side by side along a first direction;
- a connection member that connects the battery units in series, in parallel, or in series and parallel, the connection member being adjacent to one surface of each battery unit of the plurality of battery units;
- an upper cap located on and accommodating the connection member, upper portions of all of the battery units being inserted into the upper cap;
- a lower cap that is independent from and spaced apart from the upper cap by a predetermined gap such that the upper cap and the lower cap do not contact each other, lower portions of all of the battery units being inserted into the lower cap;
- a label that at least partially surrounds the battery units exposed between the upper cap and the lower cap, and
- a plurality of insulators, each insulator of the plurality of insulators being disposed between adjacent battery units that face each other,

wherein:

- the upper cap and the lower cap fix an arrangement of the battery units,
- each of the battery units includes sides that are perpendicular to the one surface, the sides include:
 - a pair of first sides, the first sides of each battery unit being side by side with the first sides of all other battery units, and

7

a pair of second sides that connect the pair of first sides to each other, the second sides having a smaller width than the first sides,

the plurality of battery units are arranged such that the second sides of each of adjacent battery units face each other,

the plurality of battery units include at least three battery units that are side by side along a first direction,

the at least three battery units include:

- a first battery unit and a second battery unit which are respectively disposed in the leftmost end and rightmost end of the plurality of battery units, and
- a third battery unit between the first and second battery units,

the pair of second sides of the third battery unit directly contact insulators disposed on both sides of the third battery unit, and

the pair of second sides of the first battery unit directly contact the label and one insulator between the first battery unit and the third battery unit, respectively.

2. The battery pack of claim 1, further comprising a spacer between the second sides of adjacent battery units that face each other.

3. The battery pack of claim 2, wherein the spacer includes a first portion that insulates the second sides of the adjacent battery units from each other and a second portion that extends from the first portion to the connection member and supports the connection member.

4. The battery pack of claim 1, wherein at least one of the upper cap and the lower cap includes a skirt portion that extends toward the pair of first sides, and the label is attached to the skirt portion.

5. The battery pack of claim 4, further comprising an insulating film between at least one of the pair of first sides and the label.

6. The battery pack of claim 1, wherein:

- each battery unit includes a can that accommodates an electrode assembly, a cap plate that is combined with the can, the cap plate forming the one surface, and a first electrode tab connected to the cap plate, and
- each battery unit includes an electrode pin located on the cap plate, the electrode pin being insulated from the cap plate.

7. The battery pack of claim 6, wherein each battery unit includes a holder on the cap plate, the holder accommodating a temperature-sensing element and a second electrode tab

8

connected to the electrode pin, the holder being attached to the cap plate by a tape that extends over the holder and attaches to opposite sides of the battery unit.

8. The battery pack of claim 7, wherein the connection member is electrically connected to the electrode pin by way of the second electrode tab and is electrically connected to the cap plate by way of the first electrode tab.

9. The battery pack of claim 8, wherein the connection member includes circuit boards and protective elements mounted on the circuit boards.

10. The battery pack of claim 7, wherein the holder is coupleable with the upper cap.

11. The battery pack of claim 10, wherein one of the holder and the upper cap includes a protrusion that protrudes in a direction perpendicular to the first direction, and the other one of the holder and the upper cap includes a hole that is coupleable with the protrusion.

12. A battery pack, comprising:

- a plurality of battery units that are side by side along a first direction;
- a connection member that connects the battery units in series, in parallel, or in series and parallel, the connection member being adjacent to one surface of each battery unit of the plurality of battery units;
- an upper cap located on and accommodating the connection member, upper portions of all of the battery units being inserted into the upper cap;
- a lower cap that is independent from and spaced apart from the upper cap by a predetermined gap such that the upper cap and the lower cap do not contact each other, lower portions of all of the battery units being inserted into the lower cap;
- a spacer between sides of adjacent battery units that face each other, wherein the spacer includes a first portion that insulates the sides of the adjacent battery units that face each other from each other and a second portion that extends from the first portion to the connection member and supports the connection member by providing a space between the one surface of the battery units and the connection member; and
- a label that at least partially surrounds the battery units exposed between the upper cap and the lower cap, wherein the upper cap and the lower cap fix an arrangement of the battery units.

* * * * *